

region and Northwest, but the disturbance disappeared by an increase of pressure while central within the Lake region, and when the depression traced as number ix was moving north-eastward over the east Gulf. It should also be noted that the depression traced as number v disappeared in almost the same location near Lake Huron, while similar conditions existed in the south Atlantic states.

IX.—This depression was first observed as central in the east Gulf, near Mobile, Ala., at midnight of the 23d. It moved along the south Atlantic coast during the 24th, causing heavy rains and brisk to high winds. It was central near Wilmington, N. C., at 10 p. m. of the 24th, after which it passed north-eastward from Hatteras, the direction and force of winds reported from southern New England stations indicating that the centre of disturbance passed to the southeast of, and near, those stations.

X.—This area of low pressure developed in the Rocky Mountain region during the 26th, it having been preceded by a depression on the north Pacific coast, from which it appears to have developed as a secondary disturbance. It moved south-eastward to northern Texas during the succeeding twenty-four hours, where it changed direction to the northeast, moving over the central valleys as a trough-shaped depression extending from Lake Michigan to the west Gulf states. It was followed on the 27th and 28th by the most severe cold wave of the month, the temperature changes in the Missouri, Mississippi, and Ohio valleys being rapid, and, in many cases, ranged from 40° to 50° in twenty-four hours. After reaching the Lake region the disturbance became more contracted and the winds

increased in force after shifting to westerly throughout the Lake region and on the Atlantic coast, and velocities ranging from fifty to fifty-five miles per hour were reported on the New England coast on the 28th, when this storm was central in northern Maine. The gales continued on the 29th in the Lake region, and from Hatteras, N. C., northward to New England. This storm apparently moved northward from New England, and its centre was last located north of Anticosti on the afternoon of the 29th; after which it probably moved northeastward.

XI.—This area of low pressure appeared on the north Pacific coast on the 28th and moved southeastward with a uniform velocity of about thirty miles per hour, crossing the central Rocky Mountain region on the 30th, and its course changing to northeasterly near the one hundredth meridian. It passed to the upper Mississippi valley, where it was central at the close of the month, attended by general snows throughout the Northern States, and rains from the Ohio Valley southward to the Gulf states. When this disturbance was observed on the north Pacific coast the barometer near the centre was 29.32; while passing the central Rocky Mountain region it fell to 29.20 at Denver and Las Animas, Colo., and at 10 p. m. of the 31st the central area was inclosed by an isobar of 29.3, almost circular in form, extending over central Wisconsin, while areas of high pressure covered the lower Saint Lawrence valley and the region north of the Missouri Valley, the difference of barometer readings between the areas of high and low pressure exceeding one inch, thus causing a decided barometric gradient in both the east and west quadrants of this disturbance.

NORTH ATLANTIC STORMS FOR DECEMBER, 1887.

[Pressure in inches and millimetres; wind-force by Beaufort scale.]

The paths of the depressions that appeared over the north Atlantic Ocean during December, 1887, have been determined from international simultaneous observations by captains of ocean steamships and sailing vessels, received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

Thirteen depressions are traced, of which seven advanced eastward from Newfoundland or the Grand Banks; one occupied the ocean between the British Isles and Iceland during the 1st and 2d; two originated to the westward of the Azores; two moved northwest from the region east of the Windward Islands, and one is given an approximate westward track over the Caribbean Sea. With the exception of numbers 1, 9, and 11 the depressions pursued normal paths.

In December, 1886, ten depressions were traced, of which five passed eastward from Newfoundland; four developed over the ocean south of Nova Scotia; one first appeared over mid-ocean in about N. 55°, and one moved eastward in the vicinity of the Azores. The severest weather of the month attended the passage of a depression from south of Nova Scotia to the British Isles from the 2d to the 8th, inclusive. During the 7th and 8th storms of almost unprecedented violence raged over Great Britain, and the fall in the barometer was reported as having been unparalleled. At Orme's Head a minimum of 27.45 (697.2) was observed, while at Liverpool the barometer fell to 27.48 (698.0). During the second and third decades of the month the weather was seasonable.

In December, 1887, the depressions traced north of the fortieth parallel corresponded closely in number with the December average, and the disturbances which attended their passage were of normal intensity. In the vicinity of the West India Islands, and over the ocean south and southeast of Bermuda, there was an unusual prevalence of cyclonic disturbances during the early part of the month, occasioning loss of life and great damage to property, more particularly at the Island of Hayti. During the first decade of the month stormy weather prevailed over the entire ocean east of the seventieth meridian, and the barometric fluctuations were frequent and marked.

During the second decade severe gales continued along the trans-Atlantic tracks, and off the middle Atlantic and New England coasts. During the third decade the region of greatest storm frequency extended from the American coast north of the thirty-fifth parallel to the twentieth meridian. Compared with the corresponding month of previous years, December, 1887, did not present abnormal meteorological features over the Atlantic in the middle and northern latitudes, while over the southern part of the ocean the severe storms of the first decade constituted a noteworthy departure from the usual winter weather in that region.

In the following descriptions of the depressions traced, positions are given in degrees latitude and longitude, except in cases where twenty-five to thirty-five minutes are cited, when they are shown in degrees and half degrees:

1.—This storm was a continuation of depression number 13 traced for November, 1887, and was central December 1st about seven degrees south-southeast from Bermuda, with heavy gales over the West India Islands and northward to Nova Scotia. By the 2d the storm-centre had moved slowly northwest, and at 12 noon, Greenwich time, was located about five degrees south of Bermuda. During this date hard north to northeast gales continued west of the sixty-fifth meridian. By the 3d the depression had slowly recurved north and northeast, and during the succeeding twenty-four hours advanced east-northeast to about N. 33°, W. 56°. The chart of the 5th shows that, subsequent to 12 noon, Greenwich time, of the 4th, the centre of depression recurved to the northwest, which fact is attributed to the presence on those dates of an area of high barometer over the ocean to the east and northeast of its position, whereby it was deflected from a normal northeasterly course. During the following four days the depression pursued a somewhat rapid normal course to the British Isles and disappeared over the North Sea after the 10th, accompanied throughout by gales attaining hurricane force. The following reports relative to this storm have been rendered: Bermuda, a heavy ne. to n. gale prevailed during the 2d and 3d. Captain Mollieu, of the s. s. "Marsielle," reports: "3d, in N. 29°,"

W. 56°, at noon; 2 a. m. wind s.; later strong ssw. gale, heavy cross sea; 4th, in N. 29°, W. 59°, at noon; ssw. gale increasing."

2.—This storm was a continuation of depression number 14 traced for November, 1887, and on December 1st was central in about N. 33°, W. 46°, whence it moved north of east to about N. 34°, W. 39° by the 2d, after which it disappeared. The depression was accompanied by fresh to strong gales, and barometric pressure about 29.50 (749.3) was shown on the 1st.

3.—This depression apparently originated on the 1st off the northeast edge of the Banks of Newfoundland, whence it advanced to the northwest of the British Isles by the 6th, during which and the following date the storm-centre apparently moved southeast over the North Sea. The storm possessed moderate energy until the 5th and 6th, when pressure below 29.00 (736.6) and strong to whole gales were reported. Capt. A. J. A. Mann, of the s. s. "State of Pennsylvania," encountered a strong sw. to nw. gale on the 5th and 6th, during which the barometer fell to 29.00 (736.6) at 8 p. m. of the 5th, in N. 55°, W. 13°.

4.—This depression advanced south of east from the sixtieth parallel, in about W. 20°, to the north of Scotland by the 3d, after which it disappeared beyond the region of observation, attended on the 3d by severe gales on the northern coasts of Great Britain.

5.—This depression was central on the 4th to the eastward of the Windward Islands, whence it moved northwest to about N. 25°, W. 63° by the 5th. Recurving north and northeast the storm is traced to N. 44°, W. 32° by the 10th, after which it passed northward and united with depression number 7. This storm, in connection with depression number 1, which it closely followed, was attended by a heavy "norther" over the West Indies during the first four days of the month, during which many vessels were wrecked. On the 4th, during a violent gale, an immense wave struck the beach at Baracoa, Cuba, broke and flowed inland, destroying nearly three hundred huts and houses without, however, an attendant loss of life. On the 6th and 7th the bark "Leocadia" encountered a whole gale, veering from se. to nw.; lowest barometer at 9 p. m. of the 6th, in N. 31°, W. 56°. Captain Young, of the s. s. "Kate Fawcett," reports a gale, attaining hurricane force on the 7th; position at noon, N. 36°, W. 51° 30'. The s. s. "Orsino," on the 8th, in N. 35° 30', W. 46°, had an increasing ssw. gale, which veered to wnw. The s. s. "Westergate," on the 9th, had a terrific gale, with squalls and tremendous cross seas; wind veered from s. to nw.; position at noon, N. 38°, W. 37° 30'.

6.—This depression is given a probable westerly track over the Caribbean Sea from the 7th to the 12th, inclusive, after which it apparently passed over Central America into the Pacific Ocean. During the 7th and 8th a heavy "norther," evidently occasioned by this depression, swept over the West Indies, causing much damage to shipping.

7.—This depression passed eastward over Newfoundland, and on the morning of the 7th was central off Saint John's. By the 8th the storm-centre had moved northeast beyond the region of observation.

8.—This depression first appeared over the southern edge of the Banks of Newfoundland on the 9th, with central pressure about 29.80 (756.9), from which position it advanced to the north of Ireland by the 14th, and subsequently disappeared beyond the eastern limits of reports. As shown by the following reports, the depression augmented energy during its eastward progress: Captain Archer, of the s. s. "Tower Hill," reports a whole gale on the 11th and 12th; wind changed from se. to ne., and backed to nw.; lowest barometer, 29.38 (746.2), on the 11th, in N. 49°, W. 47° 30'. Capt. Morice, of the s. s. "Warwick," reports a gale from the 11th to the 13th; wind veered from ese. to nnw.; lowest barometer, 29.34 (745.2), at 4 a. m. of the 12th, in N. 51°, W. 30°. The s. s. "Montauk," had a whole westerly gale on the 13th and 14th; lowest barometer, 29.01 (736.8), at noon of the 14th; in N. 56°, W. 28°. The s. s. "Island" had a strong gale on the 13th and 14th; wind veered

from se. to w., and backed to ene.; lowest barometer, 28.62 (726.9), at 4 a. m. of the 14th, in N. 58° 30', W. 13°.

9.—This depression passed eastward over Newfoundland, and at noon, Greenwich time, of the 14th was central in N. 53°, W. 40°. By the 16th the centre of depression had advanced over the British Isles, its course being attended by disturbances of marked violence.

10.—This depression was a continuation of a storm which moved from the Gulf of Mexico northeastward along the coast to Newfoundland from the 14th to the 17th. By the 18th the storm-centre had advanced over Newfoundland to N. 50°, W. 50°, from which position it passed eastward and disappeared after the 19th. The depression developed great energy after the 15th, and was attended by severe storms in the vicinity of Nova Scotia and Newfoundland during the 16th and 17th.

11.—This depression pursued a track similar to, and closely followed, number 10, its progress subsequent to the morning of the 17th being marked by storms of exceptional severity off the middle Atlantic, New England, and Canadian coasts. By the 20th the storm-centre had passed to the northeast of Newfoundland, and during the next three days it moved slowly eastward and disappeared over mid-ocean after the 23d. The following reports indicate the character of the disturbances which accompanied the depression: A heavy gale prevailed along the New England coast during the night of the 17th. Captain Pearson, of the s. s. "Strathleven," reports a whole gale on the 17th and 18th; wind veered from e. by s. to sw.; lowest barometer at 4 a. m. of the 18th, in N. 40°, W. 70°.

12.—This depression moved northeastward along the coast, and on the morning of the 24th was central about three degrees east of Saint John's, N. F., whence it passed slowly north of east and disappeared over mid-ocean after the 27th. The depression was attended by strong to whole gales throughout, with barometric minima ranging to 29.00 (736.6) after the 27th.

13.—This depression appeared on the 28th southeast of the Banks of Newfoundland, and while it may have been a continuation of an area of low pressure which moved northeast off the middle Atlantic coast during the 24th and 25th, data at hand will not admit of accurately determining this point. During the 28th, 29th, and 30th the depression advanced north of east to the northward of the Azores, and on the 31st was apparently central over the ocean between the Azores and the Spanish Peninsula.

OCEAN ICE.

On chart i the positions of two icebergs reported during the month are shown by ruled shading. On the 26th the s. s. "Mentmore" passed a small berg in N. 46° 10', W. 47° 28', and on the 28th the s. s. "Austrian" passed a small berg in N. 48° 20', W. 48° 40'. For December, 1886, no icebergs were reported. In December, 1885, several bergs were observed off the Newfoundland coast and over the Banks during the latter part of the month. For December of the three preceding years no icebergs were reported.

FOG.

The limits of fog-belts to the westward of the fortieth meridian are shown on chart i by dotted shading.

As compared with the chart for the preceding month, November, 1887, the eastern and southern limits of the Newfoundland fog-belt have contracted about one degree, although in each of these months isolated fog-areas were reported off the southeast edge of the Banks. To the southward of Nova Scotia there has been a decrease in the number of fog-areas, while along the coast of the United States fog was reported about two degrees farther south than in November.

On the fifteen dates for which fog was reported near Newfoundland the meteorological conditions were as follows: On the 1st a low barometer area moved east-northeast from the Banks, the passage of its centre being preceded by southerly winds and fog. From the 2d to the 4th, inclusive, the barometer continued high in that region, and no fog was reported. During the 5th, 6th, and 7th the approach and passage of two

areas of low pressure, one from the southwest and the other from the west, were attended by fog. During the 9th a low barometer area passed eastward off the southern edge of the Banks, but no fog reports have been received for that date. During the 10th, 11th, and 12th the barometer was high and no fog appeared. On the 13th an area of low pressure passed eastward from the Gulf of Saint Lawrence, and dense fog prevailed over the Banks. From the 15th to the 22d, inclusive, fog prevailed, attending the approach of depressions which advanced northeastward along the coast and passed over Newfoundland. From the 23d to the 28th, inclusive, north to west winds prevailed over the Banks, and no fog was reported. During the 29th and 30th an area of low pressure, central over the Gulf of Saint Lawrence, occasioned south to east winds and fog over the Banks. On the 31st a shift of wind to west and northwest caused a disappearance of fog.

Fog was reported off the south coast of Nova Scotia during the 13th and 14th, with west to northwest winds and rising barometer, following the passage of an area of low pressure eastward over the Gulf of Saint Lawrence and Newfoundland on the 13th.

During the 11th and 12th a fog of unusual density extended along the coast from Cape Henlopen to Boston. During this period an area of low pressure moved northeastward along the coast from Hatteras and united off the New England coast with a low barometer area which had advanced eastward from south of Lake Erie. This fog is reported as having caused a complete suspension of navigation along the middle Atlantic coast, and on the rivers from one to two degrees inland; and its great density over so extended an area may be attributed to the abnormally large inflow into the region it covered of warm vapor-laden air from the ocean, and colder, dry air

from the continent, attending the cyclonic circulation of winds around the low barometer areas referred to.

The following are the limits of fog-areas on the north Atlantic Ocean during December, 1887, as reported by shipmasters:

Date.	Vessel.	Entered.			Cleared.		
		Lat. N.	Lon. W.	Time.	Lat. N.	Lon. W.	Time.
1	S. S. La Bretagne	47 40	45 30	1 a. m.	47 25	46 30	3 a. m.
5-6	S. S. Rugia	46 50	43 18	.....	44 32	51 00	.....
6	S. S. Erin	45 58	46 00	.....	45 48	46 40	.....
6-7	Fog at Saint John's, N. F.	.....	.....	.....	.....	.....	.....
7	S. S. Minnesota	46 31	46 43	Noon	45 16	52 04	11 a. m.
7	S. S. Erin	44 54	51 00	.....	44 50	51 20	.....
7	Fog at Saint John's, N. F.	.....	.....	.....	.....	.....	.....
11-12	S. S. Caracas	40 15	73 50	.....	Sandy Hook.	.....	.....
11-12	S. S. Haytian Republic	40 53	69 25	6 a. m.	Boston	.....	8 a. m.
11-12	S. S. British King	38 48	73 55	.....	Cape Henlopen	.....	.....
13	S. S. City of Richmond	44 13	56 42	9.40 a. m.	44 28	55 46	0.40 p. m.
13-14	S. S. Cynthia	44 05	60 02	8 a. m.	Halifax	.....	.....
15	S. S. Peruvian .....	.....	.....	4 a. m.	St. John's, N. F.	.....	Midnight.
16	Fog at Saint John's, N. F.	.....	.....	.....	.....	.....	.....
17	.....do.....	.....	.....	.....	.....	.....	.....
17	S. S. Bohemia	45 10	49 50	.....	45 08	50 07	.....
18	S. S. Jan Breydel	44 49	51 54	.....	44 42	52 20	.....
18	S. S. Belgenland	47 00	48 20	8 a. m.	45 30	54 00	8 p. m.
18	Fog at Saint John's, N. F.	46 29	43 59	8 a. m.	45 16	48 05	Midnight.
19	.....do.....	.....	.....	.....	.....	.....	.....
19	S. S. Belgenland	44 41	51 31	Noon	44 27	52 33	4 p. m.
20	Fog at Saint John's, N. F.	.....	.....	.....	.....	.....	.....
20-21	S. S. Marengo	47 22	45 34	.....	45 52	49 38	.....
20-21	S. S. Buffalo	46 40	44 12	.....	45 03	50 23	.....
20-21	S. S. Island	47 16	46 55	.....	45 30	48 40	.....
21	Fog at Saint John's, N. F.	.....	.....	.....	.....	.....	.....
22	S. S. British Prince	47 32	44 54	.....	46 53	47 05	.....
29	Fog at Saint John's, N. F.	.....	.....	.....	.....	.....	.....
29-30	S. S. Nova Scotian .....	↑	.....	8 a. m.	45 55	55 42	Noon.
30	S. S. India	42 00	50 00	.....	42 00	51 00	.....
30	Fog at Saint John's, N. F.	.....	.....	.....	.....	.....	.....

* One hundred and fifty miles east of Saint John's, N. F.
† Saint John's, N. F.

TEMPERATURE OF THE AIR (expressed in degrees, Fahrenheit).

The distribution of mean temperature over the United States and Canada for December, 1887, is exhibited on chart ii by dotted isothermal lines. In the table of miscellaneous data are given the monthly mean temperatures, with the departures from the normal, for the various stations of the Signal Service. The figures opposite the names of the geographical districts in the columns for mean temperature, precipitation, and departures from the normal, show respectively the averages for the several districts. The normal for any district may be found by adding the departure to the current mean when the departure is below the normal, and subtracting when above.

In the Lake region, Ohio Valley, southern New England, the middle Atlantic states, southern Florida, and on the Pacific coast north of the fortieth parallel, the month was slightly warmer than the average, but in all other districts it was colder. The deficiencies in the monthly mean temperatures exceed 2° over the greater part of the territory to the west of the Mississippi River, and over an extended area reaching from the mouth of the Rio Grande River northwestward to Arizona and Nevada the mean temperatures range from 4° to 8° below the normal. The excess of temperature was greatest in the upper lake region, where it amounted to from 2° to 4°.

The following are some of the most marked departures from normal temperatures at Signal Service stations:

Above normal.		Below normal.	
Alpena, Mich.	4.1	Prescott, Ariz.	8.3
Escanaba, Mich.	3.8	Winnemucca, Nev.	7.0
Mackinaw City, Mich.	3.6	Fort Grant, Ariz.	6.6
Port Huron, Mich.	2.7	Corpus Christi, Tex.	6.4
Pittsburg, Pa.	2.3	Fort Davis, Tex.	6.0
Washington City	2.2	Rio Grande City, Tex.	5.8
New York City	2.1	Abilene, Tex.	5.7
Key West, Fla.	2.0	Santa Fe, N. Mex.	5.2

RANGES OF TEMPERATURE.

The monthly and the greatest and least daily ranges of tem-

perature at Signal Service stations are given in the table of miscellaneous meteorological data. As usual the ranges were greatest over the region between the Mississippi and the Rocky Mountains, where they generally vary from 60° to 80°; the least monthly ranges occur on the Pacific coast, and are 30° or below at most stations.

The following are some of the extremes:

Greatest.		Least.	
Saint Vincent, Minn.	87.2	Tatoosh Island, Wash.	16.6
Fort Assinaboine, Mont.	81.8	Key West, Fla.	17.8
Denver, Colo.	80.2	Fort Canby, Wash.	18.3
Fort Custer, Mont.	77.9	Port Angeles, Wash.	22.6
Fort Totten, Dak.	76.2	Olympia, Wash.	25.5
Fort Stanton, N. Mex.	75.3	Portland, Oregon.	28.3
Willcox, Ariz.	75.3	San Francisco, Cal.	28.9
North Platte, Nebr.	74.2	Linkville, Oregon.	34.2

The greatest daily ranges of temperature amounted to, or exceeded, 53° at Yankton, Dak., on the 23d, Willcox, Ariz., 9th, and Fort Supply, Ind. T., 17th. The lowest daily ranges were 2°, or below, at Green Bay, Wis., on the 9th, Linkville, Oregon, 8th, and Astoria, Oregon, 22d.

FROST.

In all districts except the Southern States frosts were of daily occurrence. In the east Gulf states they were reported on the 6th, 11th, 13th, 18th, 19th, 21st, 22d, 24th to 26th, and 28th to 30th; in the west Gulf states, 5th, 6th, 9th, 12th to 14th, 16th to 31st; Florida, 19th, 29th, 30th; lower Rio Grande valley, 18th, 21st to 25th; northern California, 3d, 7th, 10th, 11th, and from 13th to 31st; southern California, 2d, 5th, 8th to 10th, 12th, 15th, 17th to 20th, 22d to 26th, 28th, 31st.

DEVIATIONS FROM NORMAL TEMPERATURES.

The following table shows for certain stations, as reported by voluntary observers, (1) the normal temperatures for a series of years; (2) the length of record during which the observations have been taken, and from which the normal has